

# **IMAGE RECOGNITION DEVICE AND LIQUID CRYSTAL DISPLAY APPARATUS HAVING THE SAME**

## **CROSS-REFERENCE TO RELATED APPLICATION**

5           This application relies for priority upon Korean Patent Application No. 2003-26249 filed on April 25, 2003, the contents of which are herein incorporated by reference in its entirety.

## **BACKGROUND OF THE INVENTION**

### **1. Field of the Invention**

10           The present invention relates to an image recognition device and an LCD (Liquid Crystal Display) apparatus having the same, and more particularly to an image recognition device capable of improving a display quality and productivity and an LCD apparatus having the same.

### **2. Description of the Related Art**

15           An amorphous-silicon thin film transistor liquid crystal display apparatus (a-Si TFT-LCD apparatus), which is a kind of flat panel display, is widely applied to an electronic instrument, for example, such as a notebook computer, a monitor, a television set, a mobile communication system, a hand-held electronic appliance and so on.

20           Also, since the a-Si TFT-LCD, generally, includes a photosensitive material that is chemically changeable in response to a light, the a-Si TFT-LCD may be broadly used to biometrics industries as a photoelectric sensor.

25           The biometrics industries relate to a personal verification system using inherent biological properties, for example, such as a fingerprint, a voice, a facial feature, a hand or an eye iris. In view of cost, convenience and accuracy, a personal verification system using the

fingerprint among the inherent biological properties is widely used.

A fingerprint recognition device, generally, is disposed on an LCD panel that displays an image. When both pixel areas of the fingerprint recognition device and the LCD panel are not exactly aligned with each other while the fingerprint recognition device is disposed on the LCD panel, a moiré image may appear thereon.

FIG. 1 is a plane view showing a conventional fingerprint recognition device disposed on an LCD panel.

As shown in FIG. 1, pixel areas of a fingerprint recognition device 120 may be misaligned with pixel areas of an LCD panel 100 while the fingerprint recognition device 120 is disposed on the LCD panel 100. Thus, a gate line 101 and a data line 102 of the LCD panel 100 may interfere with a gate line 121 and a sensing signal output line 122 of the fingerprint recognition device 120, thereby appearing a latticed pattern on the fingerprint recognition device 120.

As a result, a screen of the LCD panel 100 may be partially dark due to the latticed pattern and brightness of the LCD panel 100 may be deteriorated.

## **BRIEF SUMMARY OF THE INVENTION**

The present invention provides an image recognition apparatus capable of improving a display quality and productivity.

The present invention provides an LCD apparatus having the above image recognition apparatus.

In one aspect of the invention, an image recognition apparatus includes a transparent substrate having four sides, a plurality of gate lines spaced apart from each other in a predetermined distance, the gate lines having a predetermined slope such that the gate lines intersect with two sides of the four sides, which are adjacent to or facing each other,

a plurality of sensing signal output lines spaced apart from each other in a predetermined distance and substantially perpendicular to the gate lines, and an image recognition sensor disposed on a pixel area, the image recognition sensor sensing an image pattern of an object in response to a gate on/off signal applied through the gate lines so as to output an image recognition signal to the sensing signal output lines.

The image recognition sensor may include a photoelectric sensor that senses the image pattern using a reflecting light reflected from the object or a capacitance type image recognition sensor that senses the image pattern using a capacitance variation between the object and the image recognition sensor.

The object is a human being and the image pattern is obtained from a human finger of the human being.

In another aspect of the invention, an LCD apparatus includes an LCD panel displaying an image, an image recognition part including a transparent substrate having four sides, a plurality of gate lines spaced apart from each other in a predetermined distance, the gate lines having a predetermined slope such that the gate lines intersect with two sides of the four sides, which are adjacent to or facing each other, a plurality of sensing signal output lines spaced apart from each other in a predetermined distance and substantially perpendicular to the gate lines, and an image recognition sensor disposed on a pixel area, and a backlight assembly disposed under the LCD panel.

The image recognition sensor senses an image pattern of an object in response to a gate on/off signal applied through the gate lines so as to output an image recognition signal to the sensing signal output lines, and the backlight assembly supplying a light to the LCD panel and image recognition device.

The object is a human being and the image pattern is obtained from a human finger of the human being.

According to the image recognition apparatus and LCD apparatus, although the image recognition apparatus is misaligned with the LCD panel 210, the LCD apparatus may prevent appearance of the moiré image thereon and deterioration of the display quality of the LCD panel, thereby improving the productivity thereof.

5

## **BRIEF DESCRIPTION OF THE DRAWINGS**

The above and other advantages of the present invention will become readily apparent by reference to the following detailed description when considered in conjunction with the accompanying drawings wherein:

10        FIG. 1 is a plane view showing a conventional fingerprint recognition device disposed on an LCD panel;

FIG. 2 is a cross-sectional view showing an LCD apparatus according to an exemplary embodiment of the present invention;

15        FIG. 3 is a plane view showing a fingerprint recognition device according to an exemplary embodiment of the present invention;

FIG. 4 is a cross-sectional view taken along the line A-A' showing the fingerprint recognition device shown in FIG. 3;

FIG. 5 is a plane view showing the fingerprint recognition device combined with the LCD panel shown in FIG. 2;

20        FIG. 6 is a plane view showing a fingerprint recognition device according to another exemplary embodiment of the present invention; and

FIG. 7 is a cross-sectional view taken along the line B-B' showing the fingerprint recognition device shown in FIG. 6.

25

## **DETAILED DESCRIPTION OF THE INVENTION**

Hereinafter, an image recognition apparatus for recognizing an image pattern, for example, such as a fingerprint image from an object, will be described.

Particularly, in this exemplary embodiment, a fingerprint recognition apparatus and an LCD apparatus having the same that recognizes an image pattern, for example, such as the fingerprint image from a human being, will be described. That is, the object having the image pattern may comprise at least the fingerprint image of the human being.

FIG. 2 is a cross-sectional view showing an LCD apparatus according to an exemplary embodiment of the present invention.

Referring to FIG. 2, an LCD apparatus includes an LCD panel 210 having liquid crystal 200 for transmitting a light in response to an electrical signal provided from an external, a fingerprint recognition device 220 disposed on the LCD panel 210, for recognizing a fingerprint image corresponding to a light reflected from a sensing object, and a backlight assembly 215 disposed under the LCD panel 210, for providing the light to the LCD panel 210.

The LCD panel 210 includes a TFT (Thin Film Transistor) substrate 230, a color filter substrate 240 disposed on the TFT substrate 230 and the liquid crystal 200 interposed between the TFT substrate 230 and the color filter substrate 240.

The fingerprint recognition device 220 includes a transparent substrate 250 having a transparent material, for example, such as a glass, a fingerprint recognition sensor 260 formed on the transparent substrate 250, for sensing the fingerprint image of the sensing object, and a protection layer 270 formed over the transparent substrate 250 on which the fingerprint recognition sensor 260 is formed.

Hereinafter, the fingerprint recognition device will be described in detail with reference to accompanying drawings.

FIG. 3 is a plane view showing a fingerprint recognition device according to an

exemplary embodiment of the present invention. FIG. 4 is a cross-sectional view taken along the line A-A' showing the fingerprint recognition device shown in FIG. 3.

Referring to FIGS. 3 and 4, the fingerprint recognition device 220 includes the fingerprint recognition sensor 260 arranged in a matrix configuration so as to recognize the fingerprint image of the sensing object.

The fingerprint recognition sensor 260 includes a first TFT 400, a second TFT 410 and a storage capacitor 420. The first TFT 400 acts as a sensing TFT that senses a reflecting light reflected from the fingerprint image of the sensing object so as to output a fingerprint recognition signal and the second TFT 410 acts as a switching TFT that is switched so as to allow the sensed fingerprint recognition signal to be outputted to the external. The storage capacitor 420 includes first and second electrodes 420a and 420b facing each other and charges an electron charge corresponding to the fingerprint recognition signal output from the first TFT 400.

The first TFT 400 includes a source electrode 401, a drain electrode 402 and a gate electrode 404 and the second TFT 410 includes a source electrode 411, a drain electrode 412 and a gate electrode 414. The first TFT 400 includes a first channel area 403 formed between the source and drain electrodes 401 and 402 thereof and the second TFT 410 includes a second channel area 413 formed between the source and drain electrodes 411 and 412 thereof. The first and second channel areas 403 and 413 include amorphous silicon. The fingerprint recognition device 220 includes a gate insulating layer 430 formed over the transparent substrate 250 on which the gate electrodes 404 and 414 of the first and second TFTs 400 and 410 are formed so as to insulate the source and drain electrodes 401 and 402 of the first TFT 400 and the source and drain electrodes 411 and 412 of the second TFT 410.

The drain electrode 402 of the first TFT 400 is connected to an external power source line  $V_{DD}$  and the source electrode 401 of the first TFT 400 is electrically connected to

the source electrode 411 of the second TFT 410 by means of the storage capacitor 420. The drain electrode 412 of the second TFT 410 is connected to the sensing signal output line 450. The gate electrode 404 of the first TFT 400 and the gate electrode 414 of the second TFT 410 are connected to a sensing TFT gate line 460 and a switching TFT gate line 470, respectively. As shown in FIG. 3, the sensing TFT gate line 460 and the switching TFT gate line 470 are alternately formed with each other.

The first electrode 420a acts as a lower electrode of the storage capacitor 420 and electrically connects the source electrode 401 of the first TFT 400 and the source electrode 411 of the second TFT 410. An insulating layer 480 is formed over the transparent substrate 250 on which the first electrode 420a is formed. The second electrode 420b acts as an upper electrode of the storage capacitor 420 and is formed on the insulating layer 480 corresponding to the first electrode 420a. That is, the storage capacitor 420 includes the first electrode 420a, second electrode 420b and insulating layer 480 disposed between the first and second electrodes 420a and 420b and charges the electron charge in proportion to a light amount input into the first TFT 400.

In order to prevent the light from being incident on the second TFT 410, a shielding layer 490 is formed on the insulating layer 480 corresponding to the gate electrode 414 of the second TFT 410. A protection layer 270 is formed over the transparent substrate 250 on which the shielding layer 490 is formed.

In this exemplary embodiment, the transparent substrate 250 has first, second, third and fourth sides 300, 310, 320 and 330. The sensing TFT gate line 460 and switching TFT gate line 470 have a predetermined slope such that the sensing and switching TFT gate lines 460 and 470 intersect with two sides of the first, second, third and fourth sides 300, 310, 320 and 330, which are adjacent to or facing each other.

That is, the sensing and switching TFT gate lines 460 and 470 may intersect with the



first and second sides 300 and 310, first and third sides 300 and 320, first and fourth sides 300 and 330, second and third sides 310 and 330, second and fourth sides 310 and 330 or third and fourth sides 320 and 330. The predetermined slope of the sensing and switching TFT gate lines 460 and 470 is from about 22.5 to about 45 degrees with respect to the fourth side 330 .

The sensing signal output line 450 is substantially perpendicular to the sensing and switching TFT gate lines 460 and 470.

Thus, as shown in FIG. 3, a pixel area 510 defined by two sensing signal output lines adjacent to each other, sensing TFT gate line 460 and switching TFT gate line 470 has a rectangular shape pivoted on a predetermined direction against the first, second, third and fourth sides 300, 310, 320 and 330 of the transparent substrate 250.

FIG. 5 is a plane view showing the fingerprint recognition device combined with the LCD panel shown in FIG. 2.

Referring to FIG. 5, when the fingerprint recognition device 220 is combined with the LCD panel 210, the pixel area 510 of the fingerprint recognition device 220 is pivoted on the predetermined direction with respect to a pixel area 570 of the LCD panel 210 disposed under the fingerprint recognition device 220.

That is, the sensing TFT gate line 460 and switching TFT gate line 470 are inclined in a predetermined slope against a gate line 550 and a data line 560 of the LCD panel 210, so that the pixel area 510 defined by two sensing signal output lines adjacent to each other, sensing TFT gate line 460 and switching TFT gate line 470 has the rectangular shape pivoted on the predetermined direction against the first, second, third and fourth sides 300, 310, 320 and 330 of the transparent substrate 250.

The gate line 550 of the LCD panel 210 is extended in a first direction and arranged in a second direction substantially perpendicular to the first direction and the data line 560 is



extended in the second direction and arranged in the first direction. Thus, the pixel area 570 of the LCD panel 210, defined by two gate lines 550 adjacent to each other and two data lines 560 adjacent to each other, has a rectangular shape.

As described above, the fingerprint recognition device 220 according to the exemplary embodiment includes the sensing TFT gate line 460 and switching TFT gate line 470 having the predetermined slope with respect to the gate line 550 of the LCD panel 210. Thus, although the fingerprint recognition device 220 is misaligned with the LCD panel 210 while the fingerprint recognition device 220 is combined to the LCD panel 210, the LCD apparatus may prevent appearance of a moiré image thereon.

Hereinafter, an operation mechanism of the fingerprint recognition device will be described.

The drain electrode 402 of the first TFT 400 receives a direct current voltage  $V_{DD}$  having a predetermined voltage level and the gate electrode 404 thereof receives a bias voltage.

When the sensing object having the fingerprint image, for example, such as a human finger, makes contact with the fingerprint recognition device 220, the light emitted from the backlight assembly 215 is supplied to the fingerprint recognition device 220 through the liquid crystal 200 of the LCD panel 210.

The light supplied to the transparent substrate 250 of the fingerprint recognition device 220 is reflected from the fingerprint image of the sensing object and supplied to the first channel area 403 of the first TFT 400, thereby turning on the first TFT 400. Responsive to the light, the storage capacitor 420 charges the electron charge in proportion to the light amount supplied to the first channel area 403 of the first TFT 400.

The second TFT 410 is switched in response to a gate driving signal provided from a gate driving section (not shown) through the gate electrode 414 thereof. In order to scan the

fingerprint image, the gate driving section outputs the gate driving signal at every frame so as to switch the second TFT 410. Thus, the fingerprint image of the sensing object making contact with the fingerprint recognition device 220 may be scanned through the first TFT 400 arranged in the matrix configuration.

5           The second TFT 410 outputs a voltage signal proportional to the electron charge charged into the storage capacitor 420 through the sensing signal output line 450. Also, since the drain electrode 412 of the second TFT 410 is connected to a data reading section (not shown) of an amplifying section (not shown) by means of the sensing signal output line 450, the voltage signal output from the second TFT 410 may be amplified in a predetermined  
10       voltage level.

FIG. 6 is a plane view showing a fingerprint recognition device according to another exemplary embodiment of the present invention. FIG. 7 is a cross-sectional view taken along the line B-B' showing the fingerprint recognition device shown in FIG. 6.

Although not shown in FIGS. 6 and 7, an LCD apparatus having the fingerprint  
15       recognition device according to another exemplary embodiment of the present invention partially includes same elements as in those of the fingerprint recognition device of the LCD apparatus shown in FIGS. 3 and 4. In this exemplary embodiment, the same reference numerals denote the same elements in FIGS. 3 and 4, and thus the detailed descriptions of the same elements will be omitted.

20           The LCD apparatus includes an LCD panel 210 having a TFT substrate 230 and a color filter substrate 240, a fingerprint recognition device 220 disposed on the LCD panel 210 and a backlight assembly 215 disposed under the LCD panel 210.

The fingerprint recognition device 220 includes a fingerprint recognition sensor 260 that recognizes a fingerprint image of a sensing object using a capacitance variation and a  
25       protection layer 270 formed on the fingerprint recognition sensor 260. The sensing object

making contact with the fingerprint recognition device 220 acts as an upper electrode of a capacitor.

Referring to FIGS. 6 and 7, the fingerprint recognition sensor 260 includes a first TFT 610, a second TFT 620 and a conductive sensing electrode 630, which are formed on a transparent substrate 600.

The first TFT 610 includes a source electrode 611, a drain electrode 612 and a gate electrode 614 and the second TFT 620 includes a source electrode 621, a drain electrode 622 and a gate electrode 624. The first TFT 610 includes a first channel area 613 formed between the source and drain electrodes 611 and 612 thereof and the second TFT 620 includes a second channel area 623 formed between the source and drain electrodes 621 and 622 thereof. The first and second channel areas 613 and 623 include amorphous silicon. The fingerprint recognition device 220 includes a gate insulating layer 640 formed over the transparent substrate 600 on which the gate electrodes 614 and 624 of the first and second TFTs 610 and 620 are formed so as to insulate the source and drain electrodes 611 and 612 of the first TFT 610 and the source and drain electrodes 621 and 622 of the second TFT 620.

The drain and gate electrodes 612 and 614 of the first TFT 610 are connected to a first gate line and source electrodes 611 and 621 of the first and second TFTs 610 and 620 are electrically connected to each other by means of the conductive sensing electrode 630. The drain electrode 622 of the second TFT 620 is connected to a sensing signal output line 670 and the gate electrode 624 of the second TFT 620 is connected to a second gate line 680 adjacent to the first gate line 660.

A protection layer 650 is formed over the transparent substrate 600 on which the first TFT 610, second TFT 620 and conductive sensing electrode 630 are formed.

The conductive sensing electrode 630 acts as a lower electrode of the capacitor and the sensing object making contact with the fingerprint recognition device 220 acts as the

upper electrode of the capacitor. That is, the conductive sensing electrode 630, protection layer 650 and sensing object act as the capacitor.

The first and second gate lines 660 and 680, which are respectively connected to the gate electrodes 614 and 624 of the first and second TFTs 610 and 620, have a predetermined slope such that the first and second gate lines 660 and 680 intersect with two sides of first, second, third and fourth sides 700, 710, 720 and 730 of the transparent substrate 600, which are adjacent to or facing each other.

That is, the first and second gate lines 660 and 680 may intersect with the first and second sides 700 and 710, first and third sides 700 and 720, first and fourth sides 700 and 730, second and third sides 710 and 730, second and fourth sides 710 and 730 or third and fourth sides 720 and 730. The predetermined slope of the sensing and switching TFT gate lines 460 and 470 is from about 22.5 to about 45 degrees with respect to the fourth side 730.

The sensing signal output line 670 is substantially perpendicular to the first and second gate lines 660 and 680. The sensing signal output line 670 has a slope from about 22.5 to about 45 degrees with respect to the fourth side 730.

Thus, as shown in FIG. 6, a pixel area 690 defined by two sensing signal output lines adjacent to each other, first gate line 660 and second gate line 680 has a rectangular shape pivoted on a predetermined direction against the first, second, third and fourth sides 700, 710, 720 and 730 of the transparent substrate 600.

As described above, the fingerprint recognition device 220 according to another exemplary embodiment of the present invention includes the first and second gate lines 660 and 680 and sensing signal output line 670 having the predetermined slope with respect to first, second, third and fourth sides 700, 710, 720 and 730 of the transparent substrate 600. Thus, although the fingerprint recognition device 220 is misaligned with the LCD panel 210 while the fingerprint recognition device 220 is combined to the LCD panel 210, the LCD

apparatus may prevent appearance of the moiré image thereon.

Hereinafter, an operation mechanism of the fingerprint recognition device according to another exemplary embodiment of the present invention will be described.

5 The first TFT 610 is switched in response to a gate driving signal provided from a gate driving section (not shown) through the gate electrode 614 connected to the first gate line 660 and applies a voltage signal to the conductive sensing electrode 630.

10 The conductive sensing electrode 630 senses a capacitance corresponding to a distance between the fingerprint image of the human finger and the conductive sensing electrode 630. The capacitance may be different according to a position of the fingerprint image because a distance between a ridge portion that is protruded portion of the human finger and the conductive sensing electrode 630 and between a valley portion that is recessed portion and the conductive sensing electrode 630 is different from each other.

15 The second TFT 620 is switched in response to the gate-on signal provided from the gate driving section (not shown) through the gate electrode 624 thereof and applies the voltage signal to the sensing signal output line 670, which is corresponding the capacitance sensed by the conductive sensing electrode 630.

20 As described above, the first and second gate lines 660 and 680 of the fingerprint recognition device 220 are inclined in the predetermined slope with respect to first, second, third and fourth sides 700, 710, 720 and 730 of the transparent substrate 600. Also, the sensing signal output line 670 is substantially perpendicular to the first and second gate lines 660 and 680.

Thus, although the first and second gate lines 660 and 680 of the fingerprint recognition device 220 are misaligned with gate and data lines of the LCD panel 210, the LCD apparatus may prevent appearance of the moiré image thereon.

25 Furthermore, the LCD apparatus may prevent deterioration of the display quality of

the LCD panel and improve the productivity thereof.

Although the exemplary embodiments of the present invention have been described, it is understood that the present invention should not be limited to these exemplary embodiments but various changes and modifications can be made by one ordinary skilled in the art within the spirit and scope of the present invention as hereinafter claimed.

5